Great Basin Naturalist 50(2), 1990, pp. 161–165

OBSERVATIONS ON THE DWARF SHREW (*SOREX NANUS*) IN NORTHERN ARIZONA

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ABSTRACT.—Observations of 23 dwarf shrews (*Sorex nanus*) at Fracas Lake in Arizona extend the range of this uncommon shrew northward on the Kaibab Plateau and provide further information regarding the ecology and habitat requirements of this species. Shrews were captured in a previously unreported habitat type (Rocky Mountain montane conifer forest; Brown 1982). This study illustrates the usefulness of intensive, long-term studies and faunal surveys using pitfall traps.

Since Merriam discovered the dwarf shrew in 1895, it has been considered a rare species. For 70 years after it was named, *Sorex nanus* was known from only 18 specimens (Hoffmann and Owen 1980). With the recent use of pitfall traps this number has increased greatly (e.g., 81 *S. nanus* in Colorado [Armstrong et al. 1973], 48 in Wyoming [Brown 1967], and 16 in Arizona [Marshall and Weisenberger 1971]).

The dwarf shrew is one of many mammal species inhabiting an archipelago of forested montane islands in the western United States (Lomolino et al. 1989). The species is currently known from Montana, Wyoming, South Dakota, Colorado, Utah, New Mexico, and Arizona (Hoffmann and Owen 1980). *Sorex nanus* is known from reports of only 20 specimens from three areas in Arizona (Fig. 1; Hoffmeister 1986); no new Arizona localities have been reported for 15 years.

The first *Sorex nanus* in Arizona was collected on 17 September 1937 from the Kaibab Plateau, Coconino Co., 14.5 km east of Swamp Point within the Grand Canyon National Park (GCNP, North Rim) at an elevation of about 2,439 m (Schellbach 1948). On 28 August 1973 another specimen was taken 5.6 km from the first record, near Kanabownits Springs within the GCNP (Ruffner and Carothers 1975). Both areas typically contain mixed-conifer forest, *Picea pungens*, *Picea engelmannii*, *Abies lasiocarpa*, *Abies concolor*, *Pseudotsuga menziesii*, and *Populus tremuloides* (subalpine conifer forest; Brown 1982). Another specimen of the dwarf shrew was reported from the Kaibab Plateau by Hoffmeister (1955). It was found in the Kaibab Lodge, VT Ranch, when the lodge was opened in April 1944. The lodge is surrounded by extensive grassy meadows to the east and subalpine conifer forest to the west.

A single specimen was collected on 14 August 1959 in the White Mountains of Greenlee Co., near Hannagan Meadows, in spruce-fir forest habitat (subalpine conifer forest; Brown 1982), at an elevation of 2,805 m, extending the range into the second area of the state (Bradshaw 1961). To my knowledge, there have been no recent records of *Sorex nanus* from this area.

Marshall and Weisenberger (1971) trapped *Sorex nanus* in Arizona in a third area, near Flagstaff, in the Inner Basin of the San Francisco Mountains at elevations between 2,865 and 3,293 m. During the summer of 1969 eight specimens were taken in rocky talus and eight from mesic subalpine meadows and surrounding spruce-fir forest. The specimens reported in this article extend the known range of *Sorex nanus* in Arizona northward on the Kaibab Plateau and describe a new habitat for this species in Arizona.

STUDY AREA

The study area was Fracas Lake, Coconino Co., 9.6 km south-southwest of Jacob Lake (36°37′52″N, 112°14′20″W, elev. 2,514 m). Fracas Lake is a permanent, natural limestone

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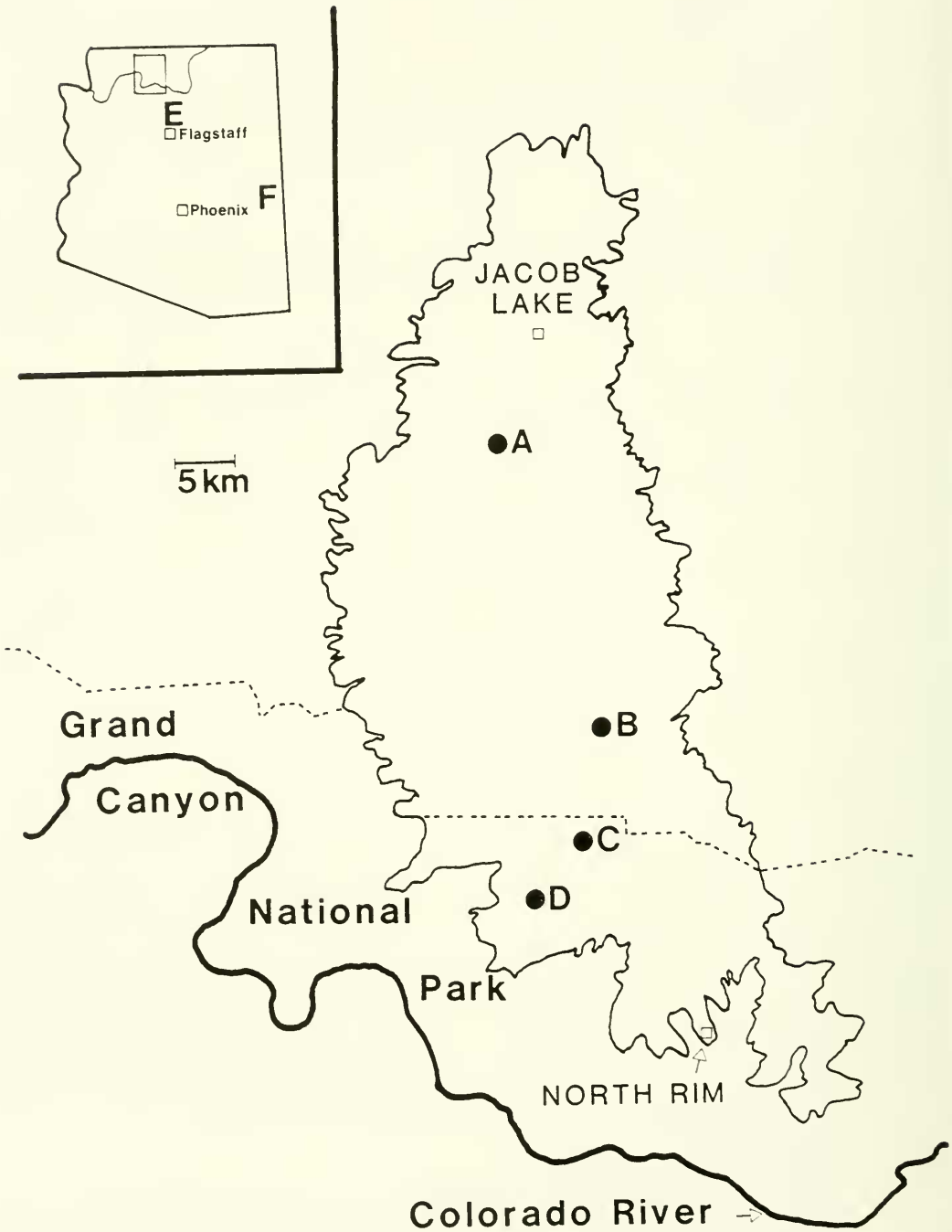

Fig. 1. Collection sites of *Sorex nanus* in Arizona. Boxed area of state enlarged. Contour line outlines Kaibab Plateau at elevation 2,195 m; A, this study; B, Hoffmeister 1955; C, Schellbach 1948; D, Ruffner and Carothers 1975; E, San Francisco Peaks (Marshall and Weisenberger 1971); F, Hannagan Meadows (Bradshaw 1961).

sinkhole basin less than 1 ha in area, varying in depth from 0.5 to 1.5 m.

The terrestrial habitat surrounding Fracas Lake is dominated by ponderosa pine (*Pinus ponderosa*) and a few aspen (*Populus tremuloides*) about 15–25 m from the edge of the lake (Rocky Mountain montane conifer forest; Brown 1982). There are a few small patches of mixed-conifer forest within 1 km of the lake; however, *Pinus ponderosa* is the dominant conifer for several square kilometers around the lake. At ground level there is little vegetation in the understory. Common shrub species include *Juniperus communis*, *Ceanothus fendleri*, *Rosa fendleri*, and *Ribes inebrians*. Short grasses occur in the open area around the lake. Only a few fallen trees and woody debris piles exist near the lake.

Mammal species (excluding bats) that I have collected or observed in association with *Sorex nanus* at this locality include: *Spermophilus lateralis*, *Eutamias umbrinus*, *Eutamias minimus*, *Tamiasciurus hudsonicus*, *Sciurus aberti kaibabensis*, *Thomomys talpoides*, *Peromyscus maniculatus*, *Microtus longicaudus*, *Erethizon dorsatum*, *Odocoileus hemionus*, and an occasional *Sylvilagus nuttalli*, *Canis latrans*, *Mustela frenata*, and *Mustela erminea* (Berna 1990).

METHODS

Sorex nanus was captured at Fracas Lake during a two-year study of the Arizona tiger salamander (*Ambystoma tigrinum nebulosum*). Fracas Lake was completely surrounded by an aluminum drift fence 214.6 m in circumference. The 40-cm-high fence was buried 7–10 cm below ground level. Two 4.5-gallon buckets were buried as pitfall traps at each of 27 stations, approximately 7 m apart. The pitfall traps were adjacent to the fence, with one bucket on each side of the fence per station. The average distance of the drift fence to the water was 8 m. Pitfall traps were checked daily from 17 May to 15 September 1988. They were checked every two weeks from 15 September until 19 November 1988 and then daily from 27 April 1989 until 14 September 1989. After 14 September they were checked once every week until 18 October 1989. Therefore, trapping occurred for 186 days in 1988 (10,044 trap nights) and 174 days in 1989 (9,396 trap nights).

TABLE 1. Monthly captures of *Sorex nanus* at Fracas Lake, Coconino Co., Arizona, in 1988 and 1989.

Month	1988	1989
April	—	0
May	0	0
June	1	3
July	1	3
August	6	6
September	3	0
October	0	0
November	0	—

Standard measurements of specimens were taken, and shrews were aged by tooth wear (Diersing and Hoffmeister 1977) and placed into two categories.

Minimum and maximum temperatures and precipitation were monitored daily throughout the study periods. Air temperatures varied from −9 to 42 C, and shrews were caught on evenings when minimum temperatures varied from 1 to 10 C. The total number of days with rain during the study in 1988 was 58, with a total rainfall of 249 mm. It rained during 34 study days in 1989, with a total rainfall of 130.5 mm.

RESULTS AND DISCUSSION

I collected 23 *Sorex nanus* during this study (Table 1). Specimens were positively identified as *Sorex nanus* based on small body size (less than 52 mm), upper third unicuspid smaller than fourth, and presence of medial tines on first incisor (Junge and Hoffmann 1981, Hoffmeister 1986). One specimen was kept as found in a mummified state, six were captured alive and released, seven were preserved as skins plus skulls, and nine were fixed in 10% formalin and later stored in 65% ethanol. Specimens have been deposited in the mammal collection at Arizona State University.

Standard body measurements, sex, and age of several dwarf shrews are reported in Table 2. Some shrews were partially eaten by carrion beetles in pitfall traps, making sex determination impossible. Mean body measurements (in mm, range in parentheses) were as follows (n = 16): total length 75 (71–77), tail length 36 (34–39), hindfoot 9 (8–10), ear from notch 6 (4–7). Mean body mass was equal to 2 g (n = 12). Reproductive condition was unambiguous for only one of the

TABLE 2. Standard measurements (length in mm, mass in g) of body size, sex, and age (Ad = adult, Juv = juvenile) of *Sorex nanus* captured at Fracas Lake during 1988 and 1989. TL = total length, T = tail length, HF = hindfoot length, E = length of ear from notch.

Date	Age	Sex	TL	T	HF	E	Mass
1988							
23 June	Ad	male	82	36	9	7	2.5
16 July	Ad	female	81	37	9	5	2.0
1 August	Ad	male	79	36	9	7	2.0
6 August	Juv	female	74	36	9	6	2.0
17 August[a]	—	?	—	—	—	—	—
21 August	Juv	male	73	34	7	6	2.0
23 August	Juv	male	72	38	9	6	1.8
30 August	Juv	male	78	38	10	7	2.0
2 September[b]	—	?	—	—	—	—	—
7 September	—	? (mummified specimen, no measurements)					
1989							
8 June	Ad	?	76	37	10	6	—
10 June	Ad	female	74	38	10	7	—
11 June	Ad	?	76	36	9	6	—
5 July	Juv	male	74	36	8	5	2.0
21 July	Juv	male	71	36	8	4	1.8
27 July	Juv	?	71	35	9	7	—
10 August[a]	—	?	—	—	—	—	—
12 August[b]	—	?	—	—	—	—	—
21 August	Juv	male	72	38	10	6	2.0
25 August	Juv	male	77	39	10	6	1.8
26 August	Juv	male	72	36	10	6	1.8

[a]Captured alive and released unharmed.
[b]Two live specimens caught on this date and released unharmed.

three females captured. The female captured on 16 July 1988 had three developing follicles greater than 2 mm in diameter.

All shrews were collected in pitfall traps outside the drift fence, suggesting that the shrews do not reside within the fenced area but use the area only as a foraging site. Juveniles were caught in July and August (Table 2), and this activity may correspond to the period of juvenile dispersal. All shrews were collected in the morning, although pitfall traps were checked twice daily. Shrews were more frequently caught on days with measurable rainfall (17 of 23, or 74% caught on days with rain). This may be due to increased foraging range when the stress of water requirements of the shrew is lessened, or it may simply correspond to increased prey activity.

Potential prey for *Sorex nanus* at this locality include spiders, which were abundant early in the season (April-June); tenebrionid beetles, common throughout the study period (May-September); and the following families and orders of invertebrates that appeared in pitfall traps at various times during the study: Formicidae, Carabidae, Scarabidae, Curculionidae, Coccinelidae, larval lepidopterans, orthopterans, and a few hemipteran and homopteran species.

Observations of three live shrews caught in pitfall traps suggested that dwarf shrews avoid tenebrionid beetles. In two instances the shrew and a few tenebrionid beetles were all that remained alive in the pitfall trap. Shrews seemed to favor carabid beetles, which they attacked voraciously with bites to the head and thorax followed by a quick retreat, and then repeated until the beetle was subdued and consumed. I also observed a shrew feeding on ants while it was in a pitfall trap.

Shrews are known to take a variety of small vertebrates as prey (Hoffmeister 1986). On two occasions in this study a *Sorex nanus* was found in the same pitfall trap as an adult tiger salamander (*Ambystoma tigrinum nebulosum*). The salamanders (snout-vent length 85–90 mm) were unharmed on both occasions, but in one instance the shrew was found dead. This may indicate an unwillingness to consume these large vertebrates with toxic skin secretions, or it may suggest that adult salamanders are much too large to be considered part of the ordinary diet of even the hungriest *Sorex nanus*.

These recent observations extend the known range of *Sorex nanus* northward on the Kaibab Plateau in Arizona 25 km from the previous record of Hoffmeister (1955). The habitat at this locality is dominated by *Pinus ponderosa*, which is a new habitat type recorded for this species in Arizona. In this study *Sorex nanus* was collected within 8 m of water, unlike previous records for Arizona (Hoffmeister 1986).

Future surveys using pitfall traps elsewhere on the Kaibab Plateau, and on other southwestern montane "islands," would be beneficial in determining the abundance and distribution of *Sorex nanus* in the southern portions of its range. They would also provide a clearer definition of the habitat requirements of this species.

ACKNOWLEDGMENTS

I thank T. R. Jones and B. Spicer for encouraging this manuscript, and D. F. Hoffmeister for providing all researchers with an excellent guide to mammals in Arizona. Many thanks for field assistance go to C. A. Schmidt, S. J. Berna, and S. L. Steele. This article benefited from comments by J. P. Collins, C. A. Schmidt, S. George, and J. A. Junge. This research indirectly benefited from funds provided by the Arizona State University Department of Zoology Graduate Student Research Fund, and Sigma Xi, the Scientific Research Society.

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Received 16 November 1989
Revised 26 January 1990
Accepted 15 April 1990